2.0 REFERENCES

A. ITFS PACE Initiative –Tasking, Dated March, 1998

B. Test Report for PACE Telecommunications Consortium-" Digital Data Transmission Using MSK Modulation," dated November 1997.

C. FCC 96-304 Declaratory Ruling and Order on the Use of Digital Modulation by Multipoint Distribution Service and Instructional Television Fixed Service Stations, July 9, 1996.

D. FCC 97-360 In the Matter of Amendment of Parts 1,21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions, October 7, 1997.

E. Developmental Broadcast Authorization, Indian River, Michigan, Dated March 10, 1998.

F. Report on Wireless Cable Interference Testing, April27-May 4, 1995. Prepared by S. Merrill Weiss, Consultant in Electronic Media Technology/Management.

G. ITFS PACE Initiative, Test Plan For Digital Data Transmission, Internet To The Schools, DN 97-179-001, Dated April 1998

3.0 FIELD TESTS

Performance/compatibility testing in the field of ITFS digital data will be for the following equipment. This includes a PACE inventory transmitter and repeater (VHF receiver/driver/transmitter less the receiver). Also tested were the SRI ITFS Digital Data Demodulator (ITFS DDD) and the ITFS Digital Data Modulator (ITFS DDM).

TABLE 3.0 EQUIPMENT UNDER TEST			
EQUIPMENT	SERIAL NUMBER	EQUIPMENT	SERIAL NUMBER
ITFS DDM	001	SB-025A CH A2	00097
ITFS DDD	001	SB-050A CH C2	00108
		R50A CH C2	00105

The test equipment used during this testing is listed in Appendix B. Testing was conducted in accordance with the referenced (Reference G) Test Plan. Any major adjustments to the test procedures are discussed herein.

3.1 Introduction

The field testing was conducted at the PACE facilities in Michigan from May 18- May 28,1998. Key participants included Bill Queen, Engineering, and Jerry Howe, Testing, of Summation Research, Inc; Dave Mania, Engineering and Mike Perri, Engineering of PACE.

3.2 Test Links

The communications channels that were tested are defined below. Link characteristics will be discussed where first used. The following links will be tested during these field tests

Table 3.2 Test Links				
LINK	FROM/TO	CHANNEL	TEST	PARA
A	Indian River(PACE)/Bear Creek	A2	PERF	4.3.11
B	PACE/Bear Creek/Wolverine	A2/C2	PERF	4.3.12
C	Bear Creek/Wolverine	C2	PERF	4.3.13
E	Bear Creek/Wolverine	C2	COMP	4.4
H	PACE/Bear Creek/PACE	A2/C2	PERF	4.3.12

3.3 Performance Testing

Performance testing will consist of Bit Error Rate tests at wideband (4Mbps) and narrowband (e.g. 128 Kbps) rates for MSK, OQPSK, QPSK, and BPSK at different power levels. Performance testing over two links was accomplished before any compatibility testing was accomplished. Test procedures were as discussed in the Test Plan.

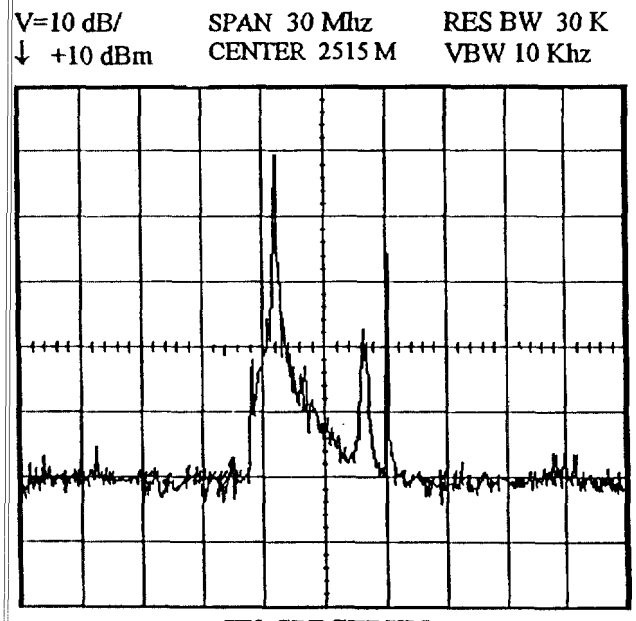
Before link testing began a complete system test, duplicating that performed during laboratory testing, was conducted to verify that the equipment was fully functional after shipment and to acquaint the PACE test personnel with the Summation Research, Inc (SRI) equipment.

3.3.1 Video vs Digital Power

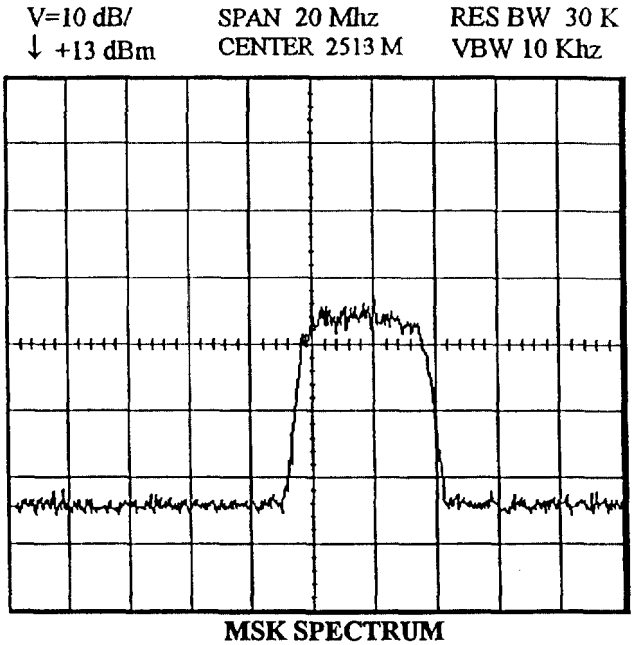
The TV-Digital Spectrum relationship for maximum digital power transmission was determined. These test results showed for the Transmitters under test that a digital power reading of 25% on the Video (VIS) power monitor was the maximum digital power allowed by the TV peak power to total digital power ratio being equal. That is full digital power-as defined by the FCC in Reference C, is 23 dB (30Khz(IFBW)/6Mhz(CBW)) below the Peak TV signal in dBm for a 30 Khz IF Bandwidth. This was 6dB (25%) below full VIS power with a normal TV input signal. This was the configuration for maximum power during all of the data transmission testing. The testing was a follows:

The A2 transmitter (25W) was used to determine the TV Video Peak to Average Data. A normal TV signal was input to the A2 Transmitter and adjusted for full power and correct visual/aural (87.5%/12.5%) ratio. After attenuation (34 dB) of the RF output of the A2 Transmitter with the power and variable attenuator a 0 dBm output for peak video power out as measured with the spectrum analyzer at 30 Khz video bandwidth was obtained. This was at 100 % of rated power. See Spectral plot 3.3.1 A. The TV inputs (VIS and AUR) were removed from the A2 Transmitter inputs. The output of the ITFS Modulator was connected to the VIS input on the A2 Transmitter. The ITFS Modulator was adjusted to provide a 4 Mbps Digital data FM modulated 2.7 Mhz frequency deviation (i.e. MSK) signal at a center frequency of 44 Mhz and its output level adjusted (e.g. –4) for -23 dBm RF power out with Spectrum Analyzer video bandwidth of 30 kHz. See Spectral plot 3.3.1 B. This level corresponds to the maximum allowed power out per the FCC rules. The -23 dBm @30 kHz corresponds to the -27.8 dBm @ 10 kHz used in the Reference F. The -23 dBm is the ratio of 6Mhz (channel BW) and Spectrum Analyzer video BW of 30 Khz (6,000,000/30,000)= 200 = 23 dB. Thus the total noise power of -23 dBm/30Khz +23dB BW adjustment = 0 dBm, the same as the Peak TV video power. The IFTS Modulator output was moved

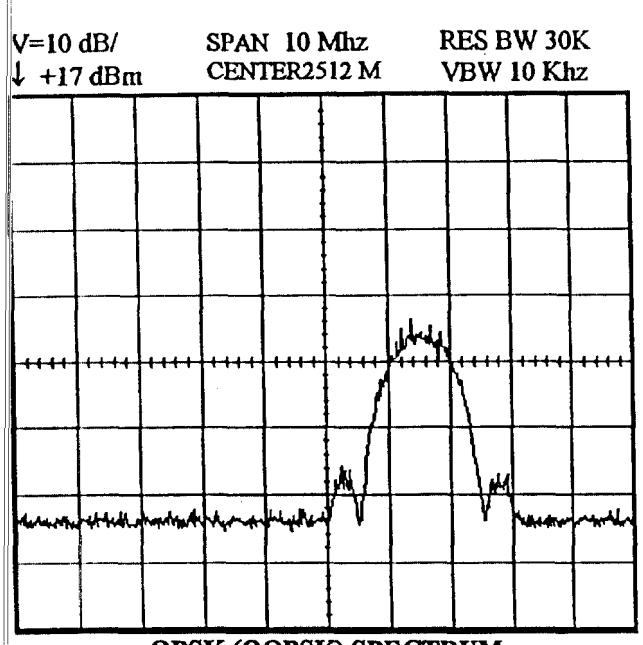
from the VIS input to the AUR input and the modulator output was adjusted for maximum output (e.g.+10). The A2 output was about 60% full power and read -27 dBm @30 Khz BW. The AUR input is attenuated 10 dB from the VIS input and this test confirmed (+10-4 -10 –23=-27) this. The modulation was changed to OQPSK and returned the input to the VIS on the transmitter. The power out of the modulator was again adjusted (e.g. -4) to obtain 25% power output on the VIS power reading. The peak output was - 18 dBm/30Khz which corresponds to about -23 dBm average over 6 Mhz . That is the –18 dBm (5 dB greater than the –23 dBm) is the peak of the standard Sin X/X spectral output with the same total power as the spectrally flat MSK signal for a 4 Mbps QPSK (or OQPSK) signal in a 6 Mhz bandwidth. See Spectral plot 3.3.1 C. The C2 (50 W) transmitter was also tested with similar results.



TV SPECTRUM
SPECTRAL PLOT 3.3.1 A



MSK SPECTRUM
SPECTRAL PLOT 3.3.1 B



QPSK (OQPSK) SPECTRUM
SPECTRAL PLOT 3.3.1 C

3.3.2 Link A (PACE (Indian River) to Bear Creek(Petoskey))

The characteristics of this direct link are shown in the following table:

Table 3.3.2 Link A (PACE to Bear Creek)	
Distance= 16.3 Miles	**Channel =** A2
Transmitter **Antenna** 16 Dbi Omni(500') **Power** 25 watt (+44 dBm) **Transmitter** SB025A	**Receiver** **Antenna** 24 dBi (220') **Down Converter** +25 Db Conifer HLNA–A in BDFH OUT **VHF Channel** CH17
S/N = +30.7Db	
Other active links A1 (25W); A3 (25W), A4(25W) at Transmit Site C1 (50W), C3 (50W), C4(50W) at Receive Site	
Comments:	

Note: S/N is computed as follows: S/N= Xmit power- Xsysloss + Xantenna – Freespace loss + Rantenna –Rsysloss – Rsensitivity(in environment) In this case Freespace loss=FSL= 106 +20 log (Dmiles) and Rsensivity (6 Mhz BW) is about –87 dBm or an equivalent NF of 17 dB)

S/N= +38 – 3 + 16 –130.3 + 24 –1 –(-87) = +30.7 (Digital)

This S/N can be viewed as having 10.7dB of fade margin and +20 dB S/N or any combination. For 4 Mbps QPSK digital data the S/N for 10E-5 BER (within 1.5 dB of theory) is about +9 dB with no fade margin; S/N for 10E-7 BER is about +11dB. For

128 Kbps, S/N for 10E-5 BER is about –6 dB; S/N for 10E-7 is about –4 dB. MSK will be about 3 dB worse.

Test results and spectrum analyzer observations follow:

TABLE 3.3.2A WIDEBAND LINK A PACE to Bear Creek							
WEATHER CLEAR AND WARM			CHANNEL A2		TIME PM(2-5) &AM(9-12)		
			EIRP=+54dBm		PACE Mania/Perri (IR/BC)		
			DATE 5/18&19		SRI Howe/Queen (IR/BC)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER MAX=	ATTN= RF2	ACTUAL BER	COM-MENTS
4.3.3 A	4 MBPS	MSK	N	38dBm +6.25W (25% of full TV Power)	-4 (Full Digital Power)	8E-09	
4.3.3 B	2 MBPS	MSK	Y			<0E-08	1
4.3.3 C	2 MBPS	OQPSK	Y			<0E-09	
4.3.3 D	4 MBPS	OQPSK	N			<0E-09	
4.3.3 E	4 MBPS	QPSK	N			<0E-09	
4.3.3 F	2 MBPS	QPSK	Y			<0E-09	
4.3.3 G	1 MBPS	BPSK	Y			<0E-08	
4.3.3 H	2 MBPS	BPSK	N			<0E-09	
4.3.4 A	4 MBPS	MSK	N	MID= Approx 30dBm +1W (4%)	-12 (8 dB down from full Digital Power)	4.8E-07	2
4.3.4 B	2 MBPS	MSK	Y			<0E-08	2
4.3.4 C	2 MBPS	OQPSK	Y			<0E-08	
4.3.4 D	4 MBPS	OQPSK	N			<0E-08	
4.3.4 E	4 MBPS	QPSK	N			<0E-08	
4.3.4 F	2 MBPS	QPSK	Y			<0E-08	
4.3.4 G	1 MBPS	BPSK	Y			<0E-08	
4.3.4 H	2 MBPS	BPSK	N			<0E-08	
4.3.5 A	4 MBPS	MSK	N	MIN= Approx 24dBm +0.25W (1%)	-18 (14 dB down from full Digital Power)	3E-05	2
4.3.5 B	2 MBPS	MSK	Y			<0E-08	2
4.3.5 C	2 MBPS	OQPSK	Y			NT	3
4.3.5 D	4 MBPS	OQPSK	N			<0E-08	
4.3.5 E	4 MBPS	QPSK	N			<0E-08	
4.3.5 F	2 MBPS	QPSK	Y			NT	3
4.3.5 G	1 MBPS	BPSK	Y			NT	3
4.3.5 H	2 MBPS	BPSK	N			<0E-08	

COMMENTS:

1. A BER of 0E-08 means there was no errors in 10E08 (100,000,000 or 100 Million) bits. Thus <0E-08 means that the BER is better than 1E-08.
2. A frequency offset of about 400 Khz provided the best FM reception.
3. NT means Not Taken –usually due to time required and commonality with other data.

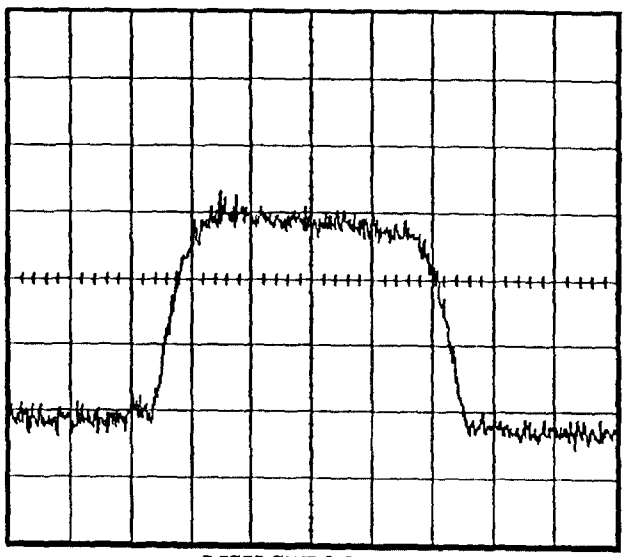
The following table shows the BER performance of the MSK and the OQPSK at different (e.g. lower) power levels. In reviewing this data the OQPSK is within 1 dB of theory with an equivalent NF on the downconverter-atmospheric noise of about 17 dB. This observation is not unreasonable for this environment. The MSK was about 3 dB worse in performance than the OQPSK given the same situation. That is also consistent with theory. The FM demodulator required careful setup to achieve this performance.

TABLE 3.3.2B WIDEBAND LINK A PACE to Bear Creek							
WEATHER CLEAR AND WARM			CHANNEL A2		TIME PM(2-5) &AM(9-12)		
			EIRP=+54Dbm		PACE Mania/Perri (IR/BC)		
			DATE 5/18&19		SRI Howe/Queen (IR/BC)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER	ATTN=	ACTUAL BER	COM-MENTS
4.3.3 A	4 MBPS	MSK	N	(<1%)	14	<0E-08	1,2
4.3.3 A	4 MBPS	MSK	N		15	2E-07	
4.3.3 A	4 MBPS	MSK	N		16	1E-06	
4.3.3 A	4 MBPS	MSK	N		17	2E-05	
4.3.3 A	4 MBPS	MSK	N		18	2E-04	
4.3.3 A	4 MBPS	MSK	N		18	5E-06	3,4
4.3.3 A	4 MBPS	MSK	N		19	7E-05	3,4
4.3.3 A	4MBPS	MSK	N		20	6E-04	3,4
4.3.5 D	4 MBPS	OQPSK	N	(<1%)	18	<0E-08	5
4.3.5 D	4 MBPS	OQPSK	N		19	NT	
4.3.5 D	4 MBPS	OQPSK	N		20	3E-07	
4.3.5 D	4 MBPS	OQPSK	N		21	3E-06	
4.3.5 D	4 MBPS	OQPSK	N		22	1.5E-05	
4.3.5 D	4 MBPS	OQPSK	N		23	7E-05	
4.3.5 D	4 MBPS	OQPSK	N		26	1.5E-04	
4.3.5 D	4 MBPS	OQPSK	N		27	9E-04	

COMMENTS:

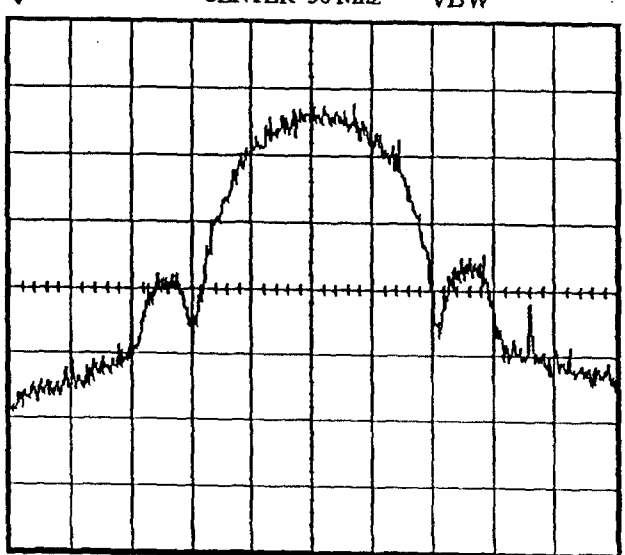
1. ATTN is adjusted to show dB down from FULL DIGITAL POWER (6.25W=+38dBm). See Spectral plot 3.3.2 A for a typical MSK signal..
2. MSK is expected to be 3 dB worse than QPSK and this data supports that.
3. Adjusted the Receiver AGC (i.e. Manual gain) to increase signal.
4. FM detector performance was sometimes difficult and had to be carefully adjusted.
5. The spectral plot of the OQPSK signal is shown in spectral plot 3.3.2 B.

V=10 dB/ SPAN 10 Mhz RES BW 30 K
↓ CENTER 36 Mhz VBW 10 Khz



MSK SPECTRUM
SPECTRAL PLOT 3.3.2 A

V=10 Db/ SPAN 10 Mhz RES BW
↓ CENTER 36 Mhz VBW



MSK SPECTRUM
SPECTRAL PLOT 3.3.2 B

The narrowband testing outlined in the test plan was not achieved on this link probably because the downconverter-an older unit - did not have the frequency stability consistent with narrowband requirements. The actual successful narrowband testing on this link is described below.

TABLE. 3.3.2C MID NARROWBAND LINK A PACE to Bear Creek							
WEATHER CLEAR AND WARM			CHANNEL A2		TIME AM (9-10)		
			EIRP=54 dBm		PACE Mania/Perri IR/BC		
			DATE 5/19/98		SRI Howe/Queen IR/BC		
PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER MAX=	ATTN	ACTUAL BER	COM-MENTS
When configured for narrowband operation at 128 Kbps, the ITFS Receiver would not lock to the received signal at the output of the older downconverter. The data rate was changed to 250 Kbps with limited results. The Narrowband FM did not function in part due to operator error in configuring the FM receive mode. Note that more extensive narrowband test results are achieved on Link C in Paragraph 3.3.4. Operation at 250 Kbps was achieved on Link A with the following results. OQPSK 250 Kbps - 30 dBm power * No Viterbi -Unreliable operation OQPSK 250 Kbps - 30 dBm power * Viterbi -Unreliable operation QPSK 250 Kbps - 30 dBm power * No Viterbi -Unreliable operation QPSK 250 Kbps - 30 dBm power * Viterbi BER <0E-07 BPSK 250 Kbps - 30 dBm power * No Viterbi BER <0E-06 BPSK 250 Kbps - 30 dBm power * Viterbi BER <0E-07							

COMMENTS:

1. The downconverter stability was clearly a major factor in the non-performance of the Narrowband.
2. This was the first time that OQPSK did not perform the same as QPSK.
3. Operator error --not properly setting up the FM demodulator- was a factor in not getting any narrowband MSK operation.

3.3.3 Link C (Bear Creek to Wolverine)

The characteristics of this direct link are shown in the following table:

Table 3.3.3 Link C (Bear Creek to Wolverine)	
Distance= 13.98 Miles	**Channel=**
Transmitter	**Receiver**
Antenna +16 dBi Omni (600')	**Antenna** 24 dBi (80')
Power 50 Watts (+ 47 dBm)	**Down Converter** +32 Db
	CalAmp 13001- Out 222-408 Mhz
	In 2500-2686 Mhz
Transmitter R50A	**VHF Channel** CH 34
S/N = 30 dB.	
Comments: This link was more complicated than that described above for the Wolverine receive site. The signal was actually received at the High School about 300 yards away; beambended and then received at the test site. The signal was then processed through a splitter/distribution amplifier/splitter to the input to the test input. The +20 dB HP amplifier was added to the signal path before the ITFS DDD (SRI ITFS Receiver) and the other +20 dB HP was used within the SRI ITFS Receiver post 36 Mhz downconverter to establish operational signal levels.	

Note: S/N is computed as follows: S/N= Xmit power- Xsysloss + X1antenna – Freespace1 loss + R1antenna + AMP+X2antenna +Freespace2- Retransmission system loss + R2antenna –R2sysloss – Rsensitivity(in environment) In this case Freespace loss=FSL= 106 +20 log (Dmiles) and Rsensivity (6 Mhz BW) is about –87 dBm or an equivalent NF of 17 dB)

S/N= +41 – 3 + 16 –129 + 24 +45+24-96-2 +24 –1 –(-87) = +30 (Digital)

)

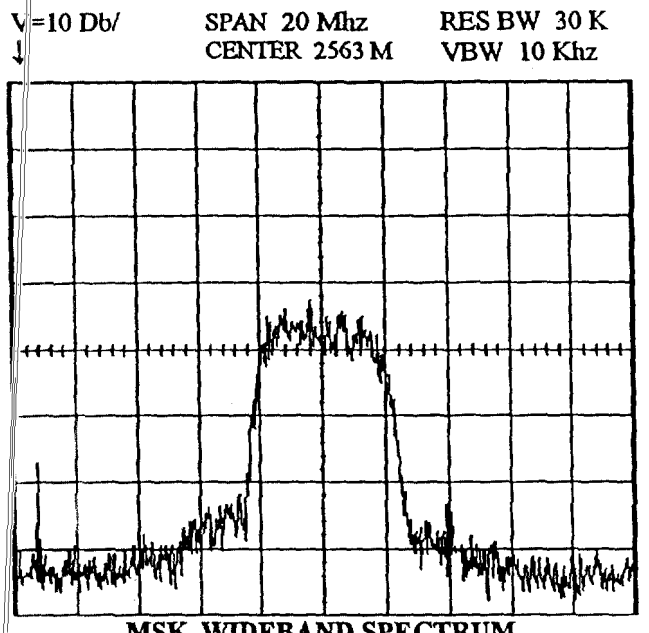
The spectrum of the C2 transmitter at Bear Creek is shown in Spectrum plot 3.3.3. A for 4 Mbps MSK with frequency deviations of 2.7 Mhz. Spectrum plot 3.3.3. B shows the same for 250 Kbps MSK with frequency deviations of 200 Khz.

Test results and spectrum analyzer observations follow.

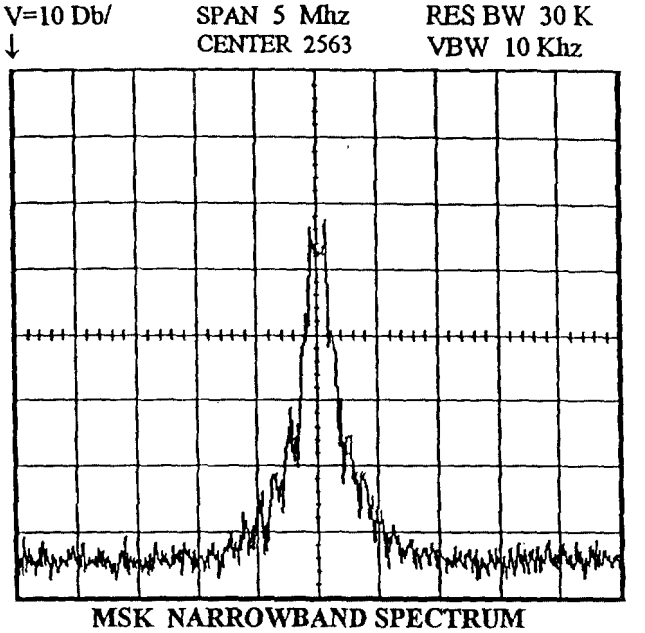
TABLE 3.3.3A WIDEBAND LINK C Bear Creek to Wolverine							
WEATHER CLEAR AND WARM			CHANNEL C2		TIME AM(9-12)		
			EIRP=+57dBm		PACE Mania/Perri (BC/W)		
			DATE 5/20&21		SRI Howe/Queen (BC/W)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER MAX=	ATTN= RF2	ACTUAL BER	NOTES
4.3.3 A	4 MBPS	MSK	N	41dBm +12.5W (25%)	-4 (Full Digital Power)	9E-08	1,3,4
4.3.3 B	2 MBPS	MSK	Y			<0E-08	1
4.3.3 C	2 MBPS	OQPSK	Y			<0E-08	
4.3.3 D	4 MBPS	OQPSK	N			4E-08	
4.3.3 E	4 MBPS	QPSK	N			<0E-08	
4.3.3 F	2 MBPS	QPSK	Y			<0E-08	
4.3.3 G	1 MBPS	BPSK	Y			NT	2
4.3.3 H	2 MBPS	BPSK	N			<0E-08	
4.3.5 A	4 MBPS	MSK	N	MIN= Approx 27Dbm +0.50W (1%)	-18 (14 dB down from full Digital Power)	1E-05	
4.3.5 B	2 MBPS	MSK	Y			<0E-08	
4.3.5 C	2 MBPS	OQPSK	Y			NT	
4.3.5 D	4 MBPS	OQPSK	N			<7E-08	
4.3.5 E	4 MBPS	QPSK	N			<2E-07	
4.3.5 F	2 MBPS	QPSK	Y			NT	
4.3.5 G	1 MBPS	BPSK	Y			NT	
4.3.5 H	2 MBPS	BPSK	N			<2E-08	

COMMENTS:

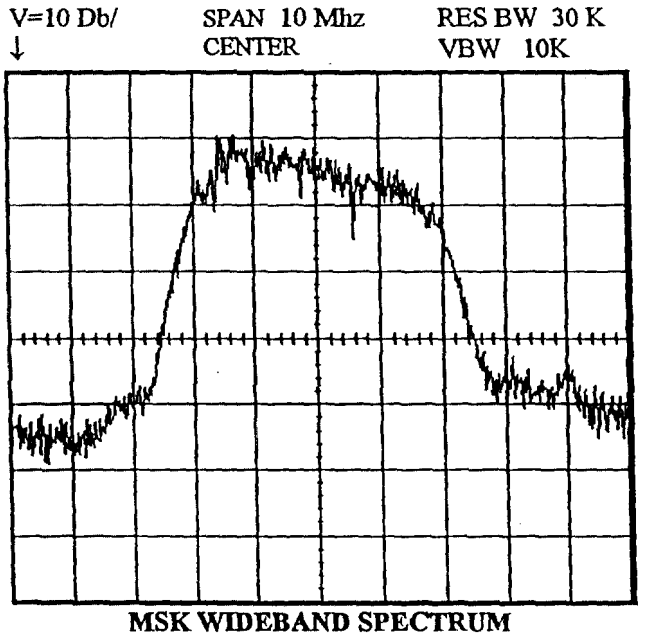
1. A BER of 0E-08 means there was no errors in 10E08 bits. Thus <0E-08 means that the BER is better than 1E-08.
2. NT means Not Taken –usually due to time required and commonality with other data.
3. Spectrum at input to ITFS DDD (SRI ITFS Receiver) for Max Power out MSK Modulation is shown in spectrum plot 3.3.3 C.
4. Spectrum plot 3.3.3 D is the same as 3.3.3 C but with a wider span. The spectrum shows the data and 3 TV channels - TV MSK TV TV.



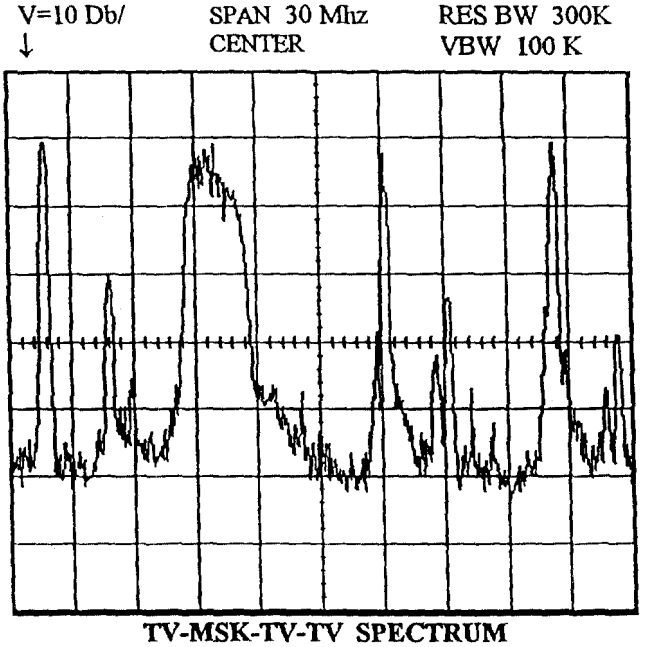
MSK WIDEBAND SPECTRUM
SPECTRAL PLOT 3.3.3 A



MSK NARROWBAND SPECTRUM
SPECTRAL PLOT 3.3.3 B



MSK WIDEBAND SPECTRUM
SPECTRAL PLOT 3.3.3 C



TV-MSK-TV-TV SPECTRUM
SPECTRAL PLOT 3.3.3 D

The following table was taken so that the BER performance of the OQPSK could be plotted for lower power levels. In reviewing this data the OQPSK is within 1 dB of theory with an equivalent LINK NF on the amplifier/down-converter/atmospheric noise of about 17 dB - not an unreasonable situation for this environment.

TABLE 3.3.3B WIDEBAND LINK C Bear Creek to Wolverine

WEATHER CLEAR AND WARM			CHANNEL C2		TIME AM(9-12)		
			EIRP=+57Dbm		PACE Mania/Perri (BC/W)		
			DATE 5/20&21		SRI Howe/Queen (BC/W)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER =	ATTN=	ACTUAL BER	NOTES
4.3.5A	4 MBPS	MSK	N	41 dBm	0	9E-08	
4.3.5B	2 MBPS	MSK	Y	41	0	0E-8	
4.3.5A'	4 MBPS	MSK	N	35	6	2E-08	1
4.3.5A'	4 MBPS	MSK	N	32	9	1E-07	
4.3.5A'	4 MBPS	MSK	N	29	12	4E-07	
4.3.5 D	4 MBPS	OQPSK	N	(<1%)	17	9E-09	2
4.3.5 D	4 MBPS	OQPSK	N		18	<0E-07	
4.3.5 D	4 MBPS	OQPSK	N		19	NT	
4.3.5 D	4 MBPS	OQPSK	N		20	1E-06	
4.3.5 D	4 MBPS	OQPSK	N		21	NT	
4.3.5 D	4 MBPS	OQPSK	N		22	2E-04	
4.3.5 D	4 MBPS	OQPSK	N		23	NT	
4.3.5 D	4 MBPS	OQPSK	N		24	2E-03	

COMMENTS:

1. ATTN is adjusted to show dB down from FULL DIGITAL POWER (12.5W=+41dBm).
2. One error at E8 toE9 transition. Probably BERT error.
3. This data matches very well the expected performance with an overall system NF(equivalent) of 17dB.

Most of the narrowband testing outlined in the test plan was achieved on this link probably because the downconverter in this link was a more stable unit than that which was used in Link A. Initial testing was at 250 Kbps vice 128Khz of the procedure. Once this was successful, the 128 Kbps testing followed.

TABLE 3.3.3C MID NARROWBAND LINK C –Bear Creek to Wolverine						
			CHANNEL	DATE		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER	ACTUAL BER	NOTE
4.3.6A'	250 KBPS	MSK	N	41dBm +12.5W (25%) Full 4 Mhz Data Power	<0E-07	
4.3.6C'	250 KBPS	OQPSK	Y		<0E-07	
4.3.6D'	250 KBPS	OQPSK	N		<0E-07	
4.3.6E'	250 KBPS	QPSK	N		<0E-07	
4.3.6F'	250 KBPS	QPSK	Y		<0E-07	
4.3.6H'	250 KBPS	BPSK	N		<0E-07	
4.3.6A''	250 KBPS	MSK	N	Full 250Kb Data Power Is 12 dB Below Above	<0E-07	
4.3.6C''	250 KBPS	OQPSK	Y		<0E-07	
4.3.6D''	250 KBPS	OQPSK	N		<0E-07	
4.3.6E''	250 KBPS	QPSK	N		<0E-07	
4.3.6F''	250 KBPS	QPSK	Y		<0E-07	
4.3.6H''	250 KBPS	BPSK	N		<0E-07	
4.3.8A'	250 KBPS	MSK	N	MIN= 20 Db below Full 250Kb Data Power	4E-05	
4.3.8C'	250 KBPS	OQPSK	Y		<0E-07	
4.3.8D'	250 KBPS	OQPSK	N		<0E-07	
4.3.8E'	250 KBPS	QPSK	N		<0E-07	
4.3.8F'	250 KBPS	QPSK	Y		<0E-07	
4.3.8G'	250 KBPS	BPSK	Y		<0E-07	
4.3.8H'	250 KBPS	BPSK	N		<0E-07	

COMMENTS: N/A

TABLE 3.3.3D MID NARROWBAND LINK C –Bear Creek to Wolverine						
			CHANNEL C2	DATE 5/21/98		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER	ACTUAL BER	NOTE
4.3.6A	128 KBPS	MSK	N	41Dbm +12.5W (25%) Full 4 Mhz Data Power	<0E-06	
4.3.6B	64 KBPS	MSK	Y		<0E-06	
4.3.6E	128 KBPS	QPSK	N		<0E-06	
4.3.6A'	128 KBPS	MSK	N	Full 128Kb Data Power Is 15 dB Below Above	<0E-06	
4.3.6E'	128 KBPS	QPSK	N		<0E-06	
4.3.8A	128 KBPS	MSK	N	MIN=18 Db below Full 128Kb Data Power	1E-05	
4.3.8E	128 KBPS	QPSK	N		<0E-06	

COMMENTS: N/A

TABLE 3.3.3E MID NARROWBAND LINK C –Bear Creek to Wolverine							
WEATHER CLEAR AND WARM			CHANNEL C2		TIME PM(2-5)		
			EIRP=+57Dbm		PACE Mania/Perri (BC/W)		
			DATE 5/21/98		SRI Howe/Queen (BC/W)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER =	ATTN=	ACTUAL BER	NOTES
4.3.8A'	250 Kbps	MSK	N	12 dB below MAX Digital Power	0	<0E-07	
4.3.8A'	250 Kbps	MSK	N		15	3E-07	1
4.3.8A'	250 Kbps	MSK	N		20	4E-05	
4.3.8A'	250 Kbps	MSK	N		24	2E-03	
4.3.8E'	250 Kbps	QPSK	N		0	<0E-07	
4.3.8E'	250 Kbps	QPSK	N		23	5E-05	
4.3.8E'	250 Kbps	QPSK	N		25	5E-04	
4.3.8E'	250 Kbps	QPSK	Y		25	<0E-07	
4.3.8G'	250 Kbps	BPSK	N		0	<0E-07	
4.3.8G'	250 Kbps	BPSK	N		25	<0E-06	
4.3.8G'	250 Kbps	BPSK	N		27	1E-06	
4.3.8G'	250 Kbps	BPSK	N		28	3E-05	
4.3.8G'	250 Kbps	BPSK	N		29	4E-05	
4.3.8G'	250 Kbps	BPSK	N		30	1E-03	
4.3.8G'	250 Kbps	BPSK	Y		33	<0E-07	

TABLE 3.3.3F MID NARROWBAND LINK C –Bear Creek to Wolverine							
WEATHER CLEAR AND WARM			CHANNEL C2		TIME PM(2-5)		
			EIRP=+57Dbm		PACE Mania/Perri (BC/W)		
			DATE 5/21/98		SRI Howe/Queen (BC/W)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER =	ATTN=	ACTUAL BER	NOTES
4.3.8A	128 Kbps	MSK	N	15 Db below MAX Digital Power	0	<0E-07	
4.3.8A	128 Kbps	MSK	N		18	<0E-07	1
4.3.8A	128 Kbps	MSK	N		19	6E-07	
4.3.8A	128 Kbps	MSK	N		20	1E-05	
4.3.8A	128 Kbps	MSK	N		21	3E-05	
4.3.8A	128 Kbps	MSK	N		22	1E-04	
4.3.8A	128 Kbps	MSK	N		23	2E-03	
4.3.8A	128 Kbps	MSK	Y		23	6E-05	
4.3.8A	64 Kbps	MSK	Y		23	1E-05	
4.3.8A	64 Kbps	MSK	Y		26	2E-05	
4.3.8E	128Kbps	QPSK	N		0	<0E-07	
4.3.8E	128Kbps	QPSK	N		20	<0E-07	
4.3.8E	128Kbps	QPSK	N		21	7E-07	
4.3.8E	128 Kbps	QPSK	N		22	1E-06	
4.3.8E	128 Kbps	QPSK	N		23	NO SYNC	
4.3.8E	128 Kbps	QPSK	Y		23	NO SYNC	

COMMENTS:

1. ATTN is the number of dB's below the Maximum for a Narrowband signal to be equivalent to a Wideband Digital signal meeting FCC requirements. That is, that power level used in the middle of the Tables 3.3.3 C&D above.

3.3.4 Link B (PACE to Bear Creek to Wolverine)

This testing was conducted after the Link C testing of Paragraph 3.3.3 as it was desired to determine the individual link characteristics before the combined non-regenerative repeat of this paragraph was tested. The characteristics of this repeated link are shown in the following table:

Table 3.3.4 Link B (PACE to Bear Creek to Wolverine)	
Distance=16.3 + 13.98=30.3 Miles	**Channel** = A2 then C2
Transmitter	**Receiver**
Antenna 16 dBi Omni (500')	**Antenna** 24 dBi (80')
Power 25 watt (+44 dBm)	**Down Converter** +25 Db
Transmitter SB025A	**VHF Channel** CH 34
Repeater	
Receiver	**Transmitter**
Antenna 24 dBi (220')	**Antenna** +16 dBi Omni (600')
Down Converter +25 Db	**Power** 50 Watts (+ 47 dBm)
VHF Channel CH17	**Transmitter** R50A
S/N = +36.7 (LINK A) S/N =30 (LINKC) or 30 dB Link AC	
Other active links A1 (25W); A3 (25W), A4(25W) at Transmit Site C1 (50W), C3 (50W), C4(50W) at Repeater Site	
Comments: This link was more complicated than that described above for the Wolverine receive site. The signal was actually received at the High School about 300 yards away, beambended and then received at the test site. The signal was then processed through a distribution amplifier/splitter to the input to the test input. The +20 dB HP amplifier was added to the signal processing before the ITFS DDD(SRI ITFS Receiver) and the other +20 dB HP was used within the ITFS DDD post 36 Mhz downconverter to establish operational signal levels.	

For this test the ITFS modulator and Data generator was reestablished at Indian River PACE where it was input to the VIS of the A2 transmitter. The A2 signal was received at Bear Creek, down converted to CH 17 using the in-place downconverter. Laboratory tests had demonstrated the incompatibility of the PACE inventory standard ITFS receiver (ITFS Repeater Model 50 Receiver) for processing digital data so the CH 17 Digital signal was downconverted once more to 44 Mhz which was input to the VIS of the C2 transmitter. This CH 17 to VIS IF conversion was accomplished by a custom downconverter provided by SRI. The C2 transmitter signal was received at Wolverine and processed the same as in Paragraph 3.3.3.

Test results for this dual hop non-regenerative repeater transmission path and spectrum analyzer observations follow:

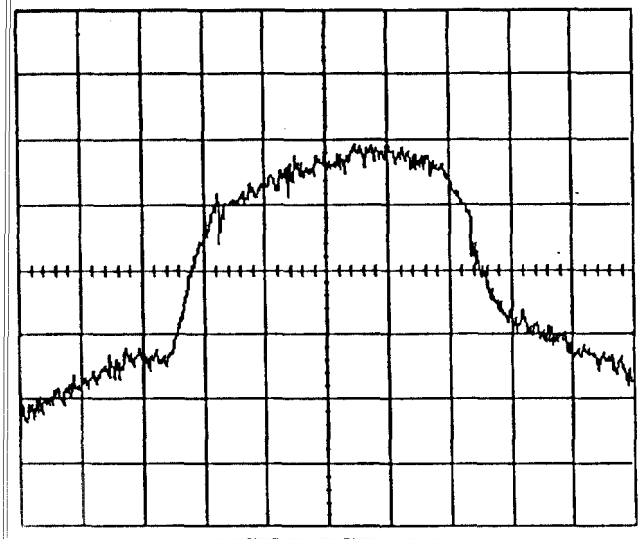
TABLE 3.3.4A WIDEBAND LINK B PACE to Bear Creek to Wolverine							
WEATHER CLOUDY AND WARM			CHANNEL A2		TIME AM(9-12)		
			CHANNEL C2		PACE Mania/Perri (IR/W)		
			DATE 5/22/98		SRI Howe/Queen (IR/W)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER MAX=	ATTN= RF2	ACTUAL BER	NOTES 334NX
4.3.3 A	4 MBPS	MSK	N	A2= 38dBm +6.25W (25%) C2= Approx 25% 12.5W	-4 (Full Digital Power)	6E-07	1,3
4.3.3 A	4 MBPS	MSK	N			1E-04	2,4
4.3.3 D	4 MBPS	OQPSK	N			<0E-08	1,5
4.3.3 D	4 MBPS	OQPSK	N			3E-04	2,6
4.3.3 E	4 MBPS	QPSK	N			<0E-08	1
4.3.3 E'	2 MBPS	QPSK	N			<0E-08	2
4.3.3 G	1 MBPS	BPSK	Y			NT	
4.3.3 H	2 MBPS	BPSK	N			<0E-08	2
4.3.4 A	4 MBPS	MSK	N	A2= 28dBm +.625W (25%) C2= Approx 2.5% 1.25W	-14	1.7E-05	1*
4.3.4 B	2 MBPS	MSK	Y			NT	*
4.3.4 C	2 MBPS	OQPSK	Y			NT	
4.3.4 D	4 MBPS	OQPSK	N			3E-08	1
4.3.4 E	4 MBPS	QPSK	N			1E-07	1
4.3.4 F	2 MBPS	QPSK	Y				
4.3.4 G	1 MBPS	BPSK	Y				
4.3.4 H	2 MBPS	BPSK	N			NO SYNC	1

NOTES.

1. Transmitter A3 at the Headend (Indian River) was causing some interference to received signal at Wolverine. Time did not permit additional evaluation but it is suspected that intermodulations in the ITFS DDD (SRI ITFS Receiver) front end is the problem.
2. Transmitter A3 was left on as with normal operation.
3. Spectral plot 3.3.4 A shows the received signal.
4. Spectral plot 3.3.4 B shows the received signal
5. Spectral plot 3.3.4 C shows the received signal.
6. Spectral plot 3.3.4 D shows the received signal.

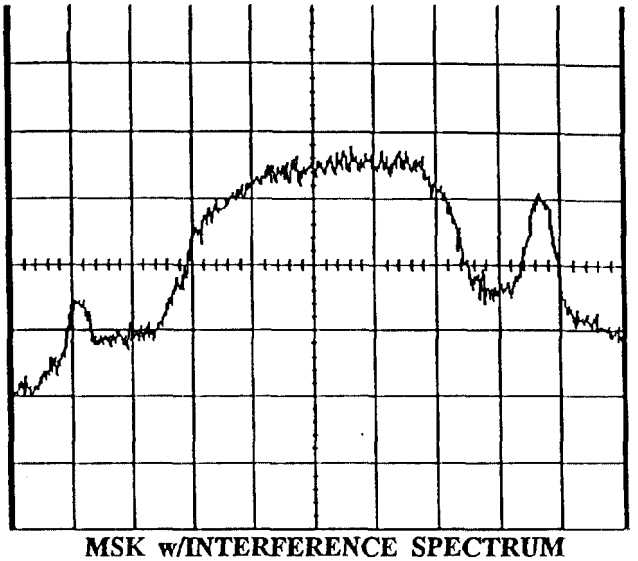
The narrowband testing outlined in the test plan was not achieved on this link because of the problems with the Narrowband on Link A from PACE to Bear Creek.

V=10 Db/ SPAN 10 Mhz RES BW 300K
↓ -30 dBm CENTER 36 Mhz VBW 10Khz



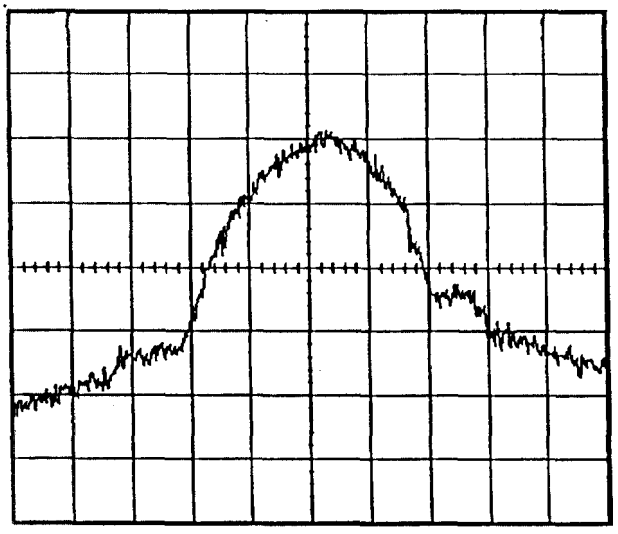
MSK SPECTRUM
SPECTRAL PLOT 3.3.4 A

V=10 Db/ SPAN 10 Mhz RES BW 300K
↓ -30 dBm CENTER 36 Mhz VBW 10 Khz



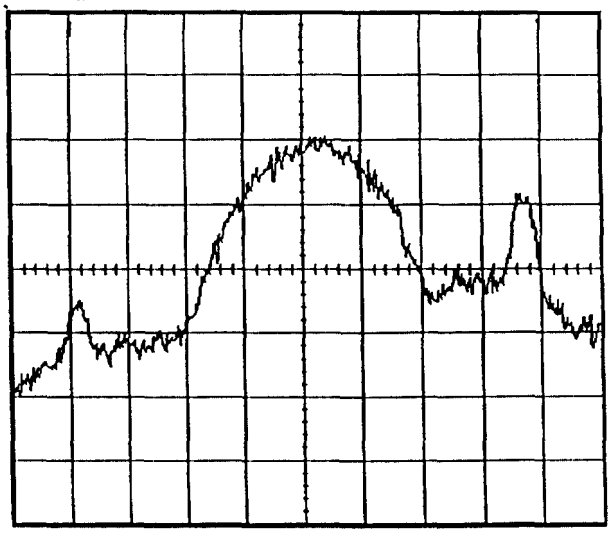
MSK w/INTERFERENCE SPECTRUM
SPECTRAL PLOT 3.3.4 B

V=10 Db/ SPAN 10 Mhz RES BW 300K
↓ -30 dBm CENTER 36 Mhz VBW 10 Khz



QPSK SPECTRUM
SPECTRAL PLOT 3.3.4C

V=10 Db/ SPAN 10 Mhz RES BW 300K
↓ -30 dBm CENTER 36 Mhz VBW 10 Khz



QPSK w/INTERFERENCE SPECTRUM
SPECTRAL PLOT 3.3.4 D

3.3.5 Link H (PACE to Bear Creek to PACE)

This testing was conducted after the Link B testing of Paragraph 3.3.4 and was in addition to that included in the test plan. The characteristics of this less complicated repeated link are shown in the following table:

Table 3.3.5 Link H (PACE to Bear Creek to PACE)	
Distance= 16.3 + 16.3=32.6 Miles	**Channel** = A2 then C2
Transmitter **Antenna** 16 dBi Omni (500') **Power** 25 watt (+44 dBm) **Transmitter** SB025A	**Receiver** **Antenna** 24 dBi **Down Converter** +25 Db **VHF Channel** CH
Repeater	
Receiver	**Transmitter**
Antenna 24 dBi (220')	**Antenna** +16 dBi Omni (600')
Down Converter +25 dB	**Power** 50 Watts (+ 47 dBm)
VHF Channel CH17	**Transmitter** R50A
S/N = +30.7 (LINK A) S/N = 33.7	
Other active links A1 (25W); A3 (25W), A4(25W) at Transmit/Receive Site C1 (50W), C3 (50W), C4(50W) at Repeater Site	
Comments:	

For this test the ITFS modulator and Data generator were reestablished at Indian River PACE where it was input to the VIS of the A2 transmitter. The A2 signal was received at Bear Creek, down converted to CH 17 using the in-place downconverter. Laboratory tests had demonstrated the incompatibility of the PACE inventory standard ITFS receiver (ITFS. Repeater Model 50 Receiver) for processing digital data so the CH 17 Digital signal was downconverted once more to 44 Mhz which was input to the VIS of the C2 transmitter. This CH 17 to VIS IF conversion was accomplished by a custom downconverter provided by SRI. The C2 transmitter signal was received back at Indian River PACE.

The calculated S/N for this return path was:

Note: S/N is computed as follows: S/N= Xmit power- Xsysloss + Xantenna – Freespace loss + Rantenna –Rsysloss – Rsensitivity(in environment) In this case Freespace loss=FSL= 106 +20 log (Dmiles) and Rsensivity (6 Mhz BW) is about –87 dBm or an equivalent NF of 17 dB)

S/N= +41 – 3 + 16 –130.3 + 24 –1 –(-87) = +33.7 (Digital)

Test results for this dual hop non-regenerative repeater transmission path and spectrum analyzer observations follow:

TABLE 3.3.5A WIDEBAND LINK H PACE to Bear Creek to PACE							
WEATHER CLOUDY AND WARM			CHANNEL A2		TIME PM(1-4)		
			CHANNEL C2		PACE Mania/Perri (IR/IR)		
			DATE 5/22/98		SRI Howe/Queen (IR/IR)		
TEST PLAN PARAGRAPH	DATA RATE	MODULATION	ENC ODE	POWER MAX=	ATTN= RF2	ACTUAL BER	NOTES X
	4 MBPS	MSK	N	A2= 38dBm +6.25W (25%) C2= Approx 25% 12.5W	-4 (Full Digital Power)	3E-04	1,2
	4 MBPS	MSK	Y			NT	
	2 MBPS	OQPSK	Y			NT	
	4 MBPS	OQPSK	N			5E-09	2
	4 MBPS	QPSK	N			9E-09	2
	2 MBPS	QPSK	Y			NT	
	1 MBPS	BPSK	Y			NT	
	2 MBPS	BPSK	N			NT	
4.3.4 A	4 MBPS	MSK	N	A2= 28dBm +.625W (25%) C2= Approx 2.5% 1.25W	-14	8E-02	1,2,3
4.3.4 B	2 MBPS	MSK	Y			NT	
4.3.4 C	2 MBPS	OQPSK	Y			NT	
4.3.4 D	4 MBPS	OQPSK	N			4E-05	
4.3.4 E	4 MBPS	QPSK	N			4E-05	2,4
4.3.4 F	2 MBPS	QPSK	Y			NT	
4.3.4 G	1 MBPS	BPSK	Y			NT	
4.3.4 H	2 MBPS	BPSK	N			NT	1

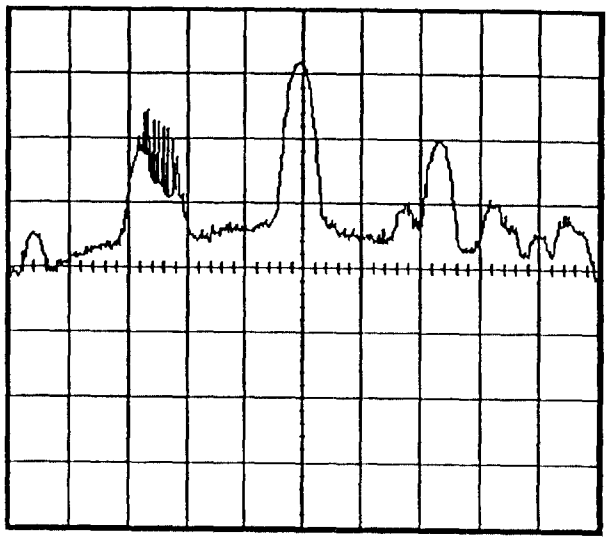
NOTES.

1. Transmitter A3 at the Headend (Indian River) was causing some interference to received signal at Indian River. Time did not permit additional evaluation but it is suspected that intermodulations in the ITFS Receiver front end may have added to the problem.
2. Transmitter A3 was left on as with normal operations
3. Spectral plot 3.3.5 A shows the received signal.
4. Spectral plot 3.3.5 B shows the received signal.

This testing was an afterthought and not enough time was available to fully determine the reasons for the demonstrated performance. It is probably caused by the A3 interference at the receive end.

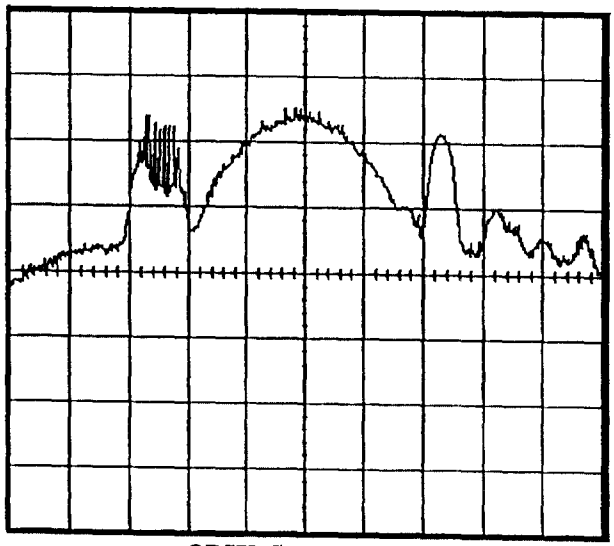
The normal narrowband testing outlined in the test plan was not achieved on this link because of the problems with the Narrowband on Link A from PACE to Bear Creek and the downconverter at PACE.

V=10 dB/ SPAN 10 Mhz RES BW 300K
↓ CENTER 36 Mhz VBW 10 Khz



MSK SPECTRUM
SPECTRAL PLOT 3.3.5 A

V=10 Db/ SPAN 10 Mhz RES BW 300K
↓ CENTER 36 Mhz VBW 10 Khz



QPSK SPECTRUM
SPECTRAL PLOT 3.3.5 B

3.4 Compatibility Testing

Compatibility testing will be accomplished with the repeater being used as the transmitter as its bandwidth is more capable of supporting three (Upper, Center, Lower) ITFS Channels. The manner in which the "interfering" channel is added to the transmission path will be described for each situation. Generally the interfering channel will be added into the transmitter using the AUR input for VIS testing and VIS input for AUR testing. Upper and lower channel transmitters were not available (only A1-A4 and C1-C4 which are every other channel so no side by side transmit channels were available). Thus, the above approach was used to accomplish the desired testing. It is important to understand that all compatibility tests were conducted in the "real world" operational environment and as such will reflect actual vs idealized results. These results will be subject to more variables, some of which cannot be controlled, as opposed to those achieved in the Wireless study discussed in the "Report on Wireless Cable Interference Testing" reference (F).

Different test scenarios were used in different tests so they will be described in detail when first used. The co-channel interference tests for both Digital onto TV and TV onto Digital were conducted on the Link described below.

Table 3.4 Test Link-Compatibility

LINK	FROM/TO	CHANNEL	TEST	PARA
E	Bear Creek/Wolverine	C2	COMP	4.4

MSK and OQPSK waveforms were used in the testing. Wideband MSK and OQPSK (or QPSK) were tested under most compatibility scenarios. Both modulations will be tested for narrowband interference with Midband narrowband being used for co-channel, lowband for Lower channel interference tests, and highband for Upper channel tests.

3.4.1 Digital onto TV Interference Tests

Please note that for this testing the desired (D) signal is the TV signal and the undesired (U) signal is the digital data. Due to system constraints the methods of generating the interference was different for co-channel and adjacent testing. The methods will be discussed in the applicable paragraph.

3.4.1.1 Co-Channel Digital to TV Interference

The characteristics of the direct link used for the co-channel interference tests are shown in the following table:

Table 3.4.1.1 A Link E Co- Channel Interference Signal Path (Bear Creek to Wolverine)	
Distance= 13.98 Miles	**Channel=** C2
Transmitter	**Receiver**
Antenna +16 dBi Omni (600')	**Antenna** 24 dBi (80')
Power 50 Watts (+ 47 dBm)	**Down Converter** +25 dB
Transmitter R50A	**VHF Channel** CH 34
S/N = + 40 dB for TV	
Comments: This link was more complicated than that described above for the Wolverine receive site. The signal was actually received at the High School about 300 yards away ;beambended, and then received at the test site. The signal was then processed through a splitter/distribution amplifier/splitter to the input to the TV Monitor.	

The mainstream video signal (Desired) was on Channel C2 with the VIS input as the Video signal input. This channel was fully operational and with maximum power. The video transmitted was a color bar test pattern to facilitate interference test level determinations. The test pattern was on a high quality VCR which drove a standard PACE inventory TV Modulator which was input to the C2 VIS input at Bear Creek at the full power level. Also, at Bear Creek, the Digital interfering signal (Undesired) was developed by the ITFS DDM Modulator and inputted to the AUR channel. The Desired/Undesired (D/U) levels and monitoring procedures were as defined in the Test Plan (Reference G). Interference levels for VIS and AUR caused by the digital signals will be determined as described below. In this case, the TV is the desired (D) signal and the digital signal is the undesired (U) signal.

In order to create co-channel interference, the ITFS DDM was configured to transmit at 44 Mhz. This undesired (U) co-channel signal was inserted into the AUR input replacing the normal AUR signal at a level (Note AUR is summed into the output with VIS at 10 dB below the VIS signal) to provide the desired D/U. The desired/undesired (D/U) ratio was established using the test plan procedures for Visual interference. Once the Visual was completed, the D/U interference Aural–AUR-interference levels was determined. In this case, the TV Modulator Aural IF out was inputted to the VIS input on the C2 Transmitter. The audio source to the TV Modulator was from a high quality active children's video. The ITFS DDM Undesired signal was input to the VIS input. Test results follow:

TABLE 3.4.1.1 A Co-Channel Interference - Digital onto TV						
WEATHER CLEAR AND WARM			CHANNEL C2		TIME AM(9-12)	
			EIRP=+63Dbm		PACE Mania/Perri (BC/W)	
			DATE 5/20		SRI Howe/Queen (BC/W)	
TEST PLAN PARAGRAPH	DES-IRED	UNDESIRED SIGNAL	ATTN	D/U RATIO	RESULTS	COMMENTS
4.4.4.4.1A	TV	4Mbps/MSK	0	12.5 Db	CCIR1	1
4.4.4.4.1A	TV	4Mbps/MSK	21	33.5	TOV	2
4.4.4.4.1A	TV	4Mbps/MSK	15	27.5	CCIR4	3
4.4.4.4.1B	TV	4Mbps/QPSK	0	12.5dB	CCIR1	1
4.4.4.4.1B	TV	4Mbps/QPSK	24	36.5	TOV	2
4.4.4.4.1B	TV	4Mbps/QPSK	18	30.5	CCIR4	3
4.4.4.4.1D	TV	4Mbps/MSK		0	-	4,5
4.4.4.4.1D	TV	4Mbps/MSK		-3	TOA	6,7
4.4.4.4.1D	TV	4Mbps/MSK		-9	CCIR4	
4.4.4.4.2A	TV	128Kbps/MSK	0	12	-	1
4.4.4.4.2A	TV	128Kbps/MSK	23	35	TOV	8
4.4.4.4.2A	TV	128Kbps/MSK	17	29	CCIR4	8
4.4.4.4.2A	TV	128Kbps/MSK		35	TOV	9
4.4.4.4.2A	TV	128Kbps/MSK		29	CCIR4	9
4.4.4.4.2B	TV	128Kbps/QPSK	0	12	-	1
4.4.4.4.2B	TV	128Kbps/QPSK	25	37	TOV	8
4.4.4.4.2B	TV	128Kbps/QPSK	19	31	CCIR4	8
4.4.4.4.2B	TV	128Kbps/QPSK	20	32	TOV	9
4.4.4.4.2B	TV	128Kbps/QPSK	14	26	CCIR4	9

COMMENTS:

1. The maximum desired to undesired ratio was determined with the maximum signal out from the ITFS DDM or at 0 ATTN. This was, as with the REF F study, the ratio of the maximum Video peak power output to the total digital channel output. In our case, using 30 Khz IF bandwidth on the Spectrum Analyzer, a D/U=1 or 0 dB would be when the digital signal was 23 dB below the peak TV video signal. With this test set up the maximum D/U that could be created was 12.5 (i.e. the maximum level of the digital signal was 35.5 dB below the Peak TV signal) due to the maximum output power of the ITFS DDM, ALC on, and the attenuation with the AUR input.
2. TOV was determined with a color bar pattern.
3. Undesired signal power was reduced 6 dB making a +6 dB change in the D/U.
4. The D/U=0 for audio interference tests was established with the audio carrier being +8 dB (digital=-23 from peak Video. Audio is 15 dB below peak.(-15-(-23)=+8) above the digital signal level.
5. The spectral plot for D/U=0 for digital onto TV audio interference is 3.4.1.1 A.
6. TOA is negative. The digital power had to be increased by 3 dB to reach TOA.
7. The spectral plot for TOA is 3.4.1.1 B.
8. The narrowband signal was set to be same as the Video carrier. This should be worst case.
9. The narrowband undesired signal was set to be the same as with the color carrier.

3.4.1.2 Adjacent Channel Digital to TV Interference

For these interference scenarios, the desired TV (Visual and Aural) signal came from a PACE inventory ITFS Modulator and upconverted (Agile Channel). This was summed with a downconverted undesired digital signal being received locally at PACE after being transmitted from PACE on Channel A2. The downconverted TV output was placed in the channel above or below the TV signal by adjusting the ITFS DDM output frequency. Atteunators were used to adjust for the desired D/U ratio. The desired/undesired (D/U) ratio was determined using the test plan procedures for Visual interference. Once the Visual was completed, the D/U interference Aural–AUR-interference levels was determined. As before, the Visual input was a color bar pattern and the audio source to the TV Modulator was from a high quality active children's video.

3.4.1.2.1 Lower Channel Digital to TV Interference

In order to create lower channel interference for the desired TV signal the ITFS DDM was tuned to 50 Mhz- one channel higher (this becomes the lower channel out of the RF Transmitter)-than the normal 44 Mhz output. D/U ratio's are established by attenuation of the undesired signal. Test results follow.

TABLE 3.4.1.2.1 Lower Channel Interference - Digital onto TV

WEATHER CLEAR AND WARM			CHANNEL C2		TIME PM(1-2)	
			EIRP=+63Dbm		PACE Mania/Perri (BC/W)	
			DATE 5/20		SRI Howe/Queen (BC/W)	
TEST PLAN PARAGRAPH	DES-IRED	UNDESIRED SIGNAL	ATTN	D/U RATIO	RESULTS	COMMENTS
4.4.4.4.1E	TV	4Mbps/MSK		0		1,2
4.4.4.4.1E	TV	4Mbps/MSK	-3	-3	TOV	3
4.4.4.4.1E	TV	4Mbps/MSK	-9	-9	CCIR4	4
4.4.4.4.1F'	TV	4Mbps/QPSK	5	+5		5
4.4.4.4.1F'	TV	4Mbps/QPSK		-5	TOV	
4.4.4.4.1F'	TV	4Mbps/QPSK		-11	CCIR4	
4.4.4.4.2E	TV	128Kbps/MSK		-3	TOV	6
4.4.4.4.2E	TV	128Kbps/MSK		-9	CCIR4	
4.4.4.4.1H	TV	4Mbps/MSK	-	<-5	TOV	7
4.4.4.4.1H	TV	4Mbps/MSK	-	<-11	CCIR4	7
4.4.4.4.1G'	TV	4Mbps/QPSK		<-5	TOV	7,8
4.4.4.4.1G'	TV	4Mbps/QPSK		<-11	CCIR4	7
4.4.4.4.1H	TV	4Mbps/MSK	-	<-10	TOA	7
4.4.4.4.1G'	TV	4Mbps/QPSK		<-10	TOA	7
4.4.4.4.2E'	TV	250Kbps/MSK		<-5	TOV	7,9
4.4.4.4.2F"	TV	250Kbps/QPSK		<-5	TOV	7,10